BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE OCCUPATIONAL SAFETY AND HEALTH STANDARD 48-139

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Occupational Health

LASER RADIATION PROTECTION PROGRAM

OPR: AFMOA/SGOR (Maj Kristin N. Swenson)

Certified by: AFMOA/CC (Lt General Paul K. Carlton, Jr.)

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The criteria in this standard represents the Air Force's minimum requirements for a Laser Radiation Protection Program. It assigns responsibilities for healthful and safe operations of laser systems and outlines the requirements of a proper protection program. The basic elements of the program imitate those of American National Standards Institute (ANSI) Z136.1, *American National Standard for Safe Use of Lasers*. Major Commands (MAJCOMs), Direct Reporting Unit (DRU), and Field Operating Agencies (FOA) may supplement this standard when additional or more stringent safety and health command unique criteria are required. Refer to Air Force Instruction (AFI) 91-301, *Air Force Occupational and Environmental Safety, Fire Prevention, and Health (AFOSH) Program* for instructions on processing supplements or variances. Report conflicts in guidance between this standard, federal standards, or other Air Force (AF) directives through MAJCOM, DRU, or FOA medical channels to Air Force Medical Operations Agency/Surgeon General's Radiation Protection Division (AFMOA/SGOR), 110 Luke Avenue, Room 405, Bolling AFB DC 20332-7050, on AF Form 847, **Recommendation for Changes of Publication**. Maintain and dispose of records created as a result of processes prescribed in this document IAW AFMAN 37-139, Records Disposition Schedule.

No Technical Order (TO), AFOSH standard, or Operating Instruction (OI) can possibly address every hazard or potential hazard that may arise from a specific task or combination of tasks. Where situations exist that do not appear to be adequately covered by existing directives, use an Operational Risk Management (ORM) process to assess risk associated with those situations and determine adequate safeguards or procedures to manage the risk. **NOTE:** The ORM process may not be used to violate directives or other regulatory guidance. Normal waiver or variance procedures must be followed in all cases (refer to the first paragraph on page 1).

SUMMARY OF REVISIONS

This AFOSH standard replaces AFOSH Standard 161-10 in its entirety. Significant changes include adoption of current laser protection standards contained in the most recent version of ANSI Publication Z136.1 and the American Conference of Governmental Industrial Hygienists (ACGIH). In addition, it

incorporates the latest Air Force policy guidance on medical surveillance requirements for personnel working with or around lasers, use of atmospheric attenuation coefficients in laser hazard assessments, revised policy guidance on laser range and outdoor laser light shows, and information on the safe use of Multiple Integrated Laser Engagement System (MILES) and HAVIS Shield combat simulation systems. It addresses specific requirements for aircrew and related ground personnel. Additionally, it delineates the proper procedure for the approval of any laser system entering the Air Force inventory. This revision also reflects a change in the publication number from AFOSH Standard 48-10 to AFOSH Standard 48-139.

Chapter 1

RESPONSIBILITIES

1.1. Secretary of the Air Force (SAF):

1.1.1. Office of the Assistant Secretary (Acquisition) (SAF/AQ):

1.1.1.1. Ensures that Air Force laboratories, Program Managers and Program Execution Officers address the issues of health and safety early and throughout the Research, Development, Test and Evaluation (RDT&E) cycle and obtains measured personnel hazard data for all lasers at the earliest possible time in the cycle for inclusion into applicable Technical Orders (TOs).

1.1.1.2. Ensures Air Force development programs incorporate the requirements of Federal Law (Title 21 Code of Federal Regulation and Department of Defense Instruction (DoDI) 6055.11, Protection from Radiofrequency Radiation and Lasers) into the early design stages of laser systems. Where full compliance with 21 Code of Federal Regulation (CFR) is not possible because of operational needs, ensures the laser is properly exempted in accordance with Federal Drug Administration (FDA) Exemption No. 76 EL-01-DOD (see DoDI 6055.11.) Establish appropriate life-cycle controls on the laser system to ensure compliance with accountability and disposal requirements of the exemption.

1.1.2. Deputy Assistant Secretary of the Air Force (Environment, Safety and Occupational Health)(SAF/MIQ). Provides oversight for all Air Force policy related to Environment, Safety, and Occupational Health.

1.2. Air Staff . All Air Staff elements will ensure their activities are conducted in a manner consistent with the spirit and intent of this standard.

1.2.1. The Surgeon General (SG):

1.2.1.1. Establishes USAF policy for the control of laser radiation hazards.

1.2.1.2. Establishes laser radiation exposure standards.

1.2.1.3. Acts as the approval authority for waivers of protection standards and control procedures to include exemptions filed under FDA Exemption No. 76 EL-01-DOD. Further ensures all FDA exemption requests are reviewed by the Air Force Staff Judge Advocate prior to approval.

1.2.1.4. Designates Air Force Medical Service voting members to the Department of Defense (DoD) Laser Systems Safety Working Group (LSSWG).

1.2.1.5. Provides guidance on proper procedure and final approval of laser systems entering the Air Force Inventory.

1.2.1.6. Establishes a Laser Safety Review Board and provides board members from AFMOA/SGOR, AFMOA/SGOE and AFMOA/SGOA for approval of new laser systems as described in **chapter 5**. Provides final safety approval authority through AFMOA/SGO.

1.2.2. Air Force Safety Center (HQ AFSC):

1.2.2.1. Implements standards approved by the Air Force Surgeon General (HQ USAF/SG) for safety programs associated with hazardous laser radiation exposure.

1.2.2.2. Implements safety standards for non-biological hazards of laser systems and equipment, e.g., electrocution, toxic gas, blindness, etc.

1.2.2.3. Provides a board member for approval of new laser systems that are part of a weapon system as described in **chapter 5**.

1.2.3. Air Force Inspection Agency (HQ AFIA). Implements programs to assess compliance with the requirements in this standard.

1.2.4. Air Force Judge Advocate (HQ AFLSA/JACE). Reviews legal issues associated with use of lasers in the military.

1.2.5. Air Force Civil Engineer Support Agency (HQ AFCESA/CES). Technical Support Directorate establishes criteria for fire protection and life safety in laser facilities and laser system support facilities.

1.3. Air Force Materiel Command (AFMC):

1.3.1. Plans and Programs. Plans, programs, and budgets for research and development relating to the health and safety of laser radiation, laser protective devices, laser technologies and laser control measures.

1.3.2. Contracting. Ensures its laboratories and Single Managers address the issues of health and safety early and throughout the RDT&E cycle. Ensures a system safety program, consistent with Military Standard (Mil Std) 882, *System Safety Program Requirements* and requirements of AFI 91-202, *The US Air Force Mishap Prevention Program*, Chapter 9, *System Safety* to support development or modification of laser systems. The system safety program shall be initiated as early as possible in the development or modification cycle to ensure effective total life cycle risk and costs management. In addition, all contracts for operation, modification and repair of laser systems will incorporate appropriate safety controls.

1.3.3. Policy and Procedures. Develops and implements policies and procedures to ensure that required personnel hazard data for lasers is measured at the earliest possible time in the acquisition cycle and is made available to the appropriate agency.

1.3.4. HQ AFMC/SG Coordination. Coordinates with HQ AFMC/SG on technical orders, handbooks, and similar publications to ensure they contain these health procedures and precautions needed to prevent the exposure of personnel to laser radiation in excess of this standard.

1.3.5. Air Force Research Laboratory (AFRL):

1.3.5.1. Conducts research on the biological effects of laser radiation.

1.3.5.2. Maintains technical expertise in laser technology and new developments that may affect laser safety in Air Force operations.

1.3.5.3. Coordinates and works with other AFMC laboratories, AF MAJCOMs and other agencies to evaluate, assess and resolve operational issues on any new or unusual laser radiation issues.

1.3.5.4. Conducts research to develop tools and techniques to determine laser hazards and analyze laser safety.

1.3.5.5. Assists System Program Office or Program Manager in evaluating system hazards and application for FDA exemption for new or unique laser systems.

1.3.5.6. Tests and develops Laser Eye Protection technologies for Air Force use against both in-band and out-of-band lasers.

1.3.5.7. Coordinates development and approval of laser eye protection (LEP) technologies for transition to Air Force operational use. This will include working with the Human Systems Program Office to secure "Safe-to-Fly" approval for aircrew LEP prior to fielding, or "Safe-to-Fly" recommendation in the case of pre-fielding activities such as operational assessments of LEP in development.

1.3.5.8. Along with standards development determines and establishes acceptable atmospheric attenuation coefficients for use in laser hazard assessments.

1.3.5.9. Provides a board member for approval of new laser systems as described in **chapter 5**.

1.3.6. Human Systems Program Office (311 HSW/YA):

1.3.6.1. Responsible for the acquisition and sustainment of LEP for aircrew.

1.3.6.2. Issues "Safe-to-Fly" approval for LEP stocklisted and issued for USAF operational use.

1.3.6.3. Assists AFRL, test organizations, and MAJCOMs with assessments of LEP technologies/devices under development for aircrew. Provides "Safe-to-Fly" recommendation for pre-fielding flying activities such as operational assessments, developmental tests and operational tests. This "Safe-to-Fly" recommendation is then used by the MAJCOM/FOA, who then approves the use of developmental LEP by their aircrews in their aircraft.

1.3.7. Through the Institute for Environment, Safety, Occupational Health and Risk Analysis (IERA):

1.3.7.1. Provides information to using commands, during contingency and peacetime operations, on the adequacy of laser radiation protective devices, materials, and engineering control measures.

1.3.7.2. Serves as the HQ USAF/SG technical center for all issues concerning laser safety.

1.3.7.3. Provides professional advice and guidance applicable to laser radiation exposure control and medical surveillance.

1.3.7.4. Maintains a repository on the characteristics of operational lasers, commercial lasers, and laser radiation protective devices used within the Air Force and make this repository electronically available to appropriate installation personnel.

1.3.7.5. Maintains an ability to conduct field laser radiation surveys required to support this standard.

1.3.7.6. Works with other AFMC laboratories, AFRL and other services to evaluate any unique or unusual laser radiation safety issues and resolve operational problems.

1.3.7.7. Maintains an official repository of suspected exposure investigations to laser radiation, and submits an annual summary report of incidents, including outcomes, possible preventive measures, and costs, to AFMOA/SGOR and MAJCOM BEEs.

1.3.7.8. Provides formal training for medical and operational personnel on laser safety through the USAF School of Aerospace Medicine, Department of Bioenvironmental Engineering (USAFSAM/BE).

1.3.7.9. Provides a board member for approval of new laser systems as described in **chapter 5**.

1.3.8. USAF School of Aerospace Medicine (USAFSAM):

1.3.8.1. Provides consultative examinations in ophthalmology and dermatology for USAF personnel. All other consultations must have approval from 311th HSW/CC.

1.3.8.2. Develops methods to evaluate occupational injuries from lasers.

1.3.8.3. Recommends medical surveillance requirements.

1.3.8.4. Provides formal training for medical personnel to ensure they are proficient in current issues involving lasers and known bioeffects associated with exposure.

1.3.8.5. Provides a board member for approval of new laser systems as described in **chapter 5**.

1.3.9. Detachment 3, IERA, Kadena AB, JA. Provides technical advice and assistance to Pacific Air Forces (PACAF) installations in meeting this standard.

1.4. US Air Force in Europe (USAFE). The 86 MDSS/SGSB, in conjunction with IERA Radiation Surveillance Division, provides technical advice and assistance to USAFE installations in meeting this standard.

1.5. USAF School of Aerospace Medicine, Department of Bioenvironmental Engineering (USAFSAM/BE):

1.5.1. Provides formal training programs for medical personnel to ensure they are proficient in conducting laser hazard assessments and measurements, and are knowledgeable about current issues involving lasers and the known bioeffects associated with exposure.

1.5.2. Works closely with AFRL researchers to ensure that instruction provided to trainees is based on the most current applicable scientific findings and in keeping with the most current Air Force policies.

1.5.3. Obtains guidance and assistance from IERA and AFRL when developing course curriculums to ensure the accuracy and applicability of information conveyed to students.

1.6. Major Commands (MAJCOMs) or Field Operating Agencies (FOAs):

1.6.1. Develops policies and procedures as may be required to implement this standard.

1.6.2. Coordinates and approves requests for changes to this standard.

1.6.3. Establishes policy and procedures to issue “Safe-to-Fly” approval on the use of Laser Eye Protection (LEP) for aircrews not otherwise approved by the Human Systems Program Office.

1.7. Installation Commander:

1.7.1. Develops policy and procedures as may be required.

1.7.2. Provides the Medical Treatment Facility (MTF) Commander with adequate authority to implement the health and safety measures required by this standard.

1.7.3. Ensures operation and maintenance activities implement measures to prevent personnel exposure to laser radiation in excess of the limits prescribed in this standard.

1.7.4. Ensures occupational safety and health is considered for each new laser operation, job, or procedure before the start of normal operations so a laser radiation survey or analysis can be scheduled or performed.

1.7.5. Implements proper corrective action according to AFI 91-301 Air Force Occupational and Environmental Safety Fire Prevention and Health Program when a risk assessment code is assigned to a hazardous laser radiation situation.

1.7.6. Ensures all personnel working in areas where hazardous levels of laser radiation are possible understand the importance of promptly reporting any visual problems or disturbances, are familiar with the sources and types of laser radiation present, and comply with appropriate operating and safety procedures.

1.7.7. Initiates immediate notification of Safety (SE), Bioenvironmental Engineering (BE) and Public Health (PH) of any suspected personnel exposure to laser radiation.

1.7.8. Provides adequate support and coordination of all incident investigations and preparation of the investigative report.

1.7.9. Ensures implementation of this standard by government contractors for operations that may impact USAF property or personnel.

1.8. Medical Treatment Facility (MTF) Commander. Develops policy and procedure to implement the occupational health and safety aspects of this standard. Ensures the Human Systems Program Office has certified all LEP used by aircrews “Safe-to-Fly”.

1.8.1. The Bioenvironmental Engineering (BE) Flight and (or) equivalent, or Designated Laser Safety Officer:

1.8.1.1. Implements and conducts a base laser safety program as required by this standard.

1.8.1.2. Conducts laser health hazard evaluations when notified of new operations, equipment changes, or any modifications that may alter potential personnel hazards. Determines the laser class, exposure limits, hazard distances and zones. Recommends engineering controls, administrative and procedural controls as necessary to the appropriate commander. Incorporate laser health hazard evaluations into special surveillance process described in AFI 48-145.

1.8.1.3. Document the hazard evaluation according to **attachment 3**.

1.8.1.4. Reports and evaluates suspected exposures and prepares reports of them for submission according to paragraph 2.6 of this standard. Coordinates reports and evaluations with the occupational physician, public health, and safety. The BE will keep the unit commander and other necessary personnel informed of actions being taken or required as part of a medical investigation as described in paragraphs 2.6.2.2. and 2.6.2.3.

1.8.1.5. Meets all training requirements of paragraph 2.4 and be able to provide laser safety training and information to designated USO and (or) LSO and other personnel as necessary.

1.8.2. The Public Health (PH) in conjunction with the Occupational Physician:

1.8.2.1. Oversees medical surveillance requirements of this standard.

1.8.2.2. Coordinates on investigations of suspected or actual laser radiation exposure.

1.8.2.3. Implements appropriate procedures for reporting and investigation of suspected Occupational Health Occurrence into the Air Force Reportable Event Surveillance System (AFRESS). Updates record status and report results in the Case Narrative block of the AFRESS Module.

1.8.2.4. Ensures medical follow-up examinations specified by the occupational medicine consultant at USAFSAM/AFC are conducted for persons identified as having been overexposed to laser radiation.

1.8.2.5. Coordinates medical follow-up examinations with USAFSAM.

1.8.3. Physical Exams:

1.8.3.1. Reviews medical records to ensure required medical surveillance is accomplish as specified in ANSI Z136.1.

1.8.3.2. Schedules examinations required for medical surveillance.

1.8.4. Medical Records. Retains medical and surveillance records associated with laser safety per federal guidelines and AF directives.

1.9. Director of Safety (SE):

1.9.1. Reviews and recommends policies and procedures to prevent mishaps from associated non-radiation laser hazards as defined in appropriate base or unit plans and directives.

1.9.2. Periodically evaluates procedures and inspects facilities to ensure compliance with safety requirements.

1.9.3. Investigates incidents related to laser ancillary safety hazards such as, electrocution, shock, etc., per AFI 91-204, *Investigation and Reporting US Air Force Mishaps.*

1.10. Base Civil Engineer Fire Protection Flight (CEF): Evaluates laser procedures and facilities to ensure compliance with National Fire Protection Standard 115, Recommended Practice on Laser Fire Protection, 1995 Edition. The installation fire chief will develop fire department emergency response plans, procedures and training lesson plans for safe fire fighting operations involving facilities and weapon systems with the potential for laser-related incidents. Firefighters assigned to these locations will receive initial and annual training on safe fire fighting operations when confronted with incidents involving lasers.

1.11. Unit Commander:

1.11.1. Develops policies, procedures, and instructions necessary to meet this standard at the unit level in cooperation with BE.

1.11.2. Includes in statements of work for contracted operations that the contractor shall comply with OSHA requirements and shall follow the safety guidelines in AFOSH Standard 48-139. The contractor shall notify the installation BE and safety office when lasers are brought onto an AF installation and when laser operations will be performed.

1.11.3. Assigns only qualified and trained workers to adjust, maintain, or operate laser equipment.

1.11.4. Appoints a unit safety officer or laser safety officer who will assist the commander to:

1.11.4.1. Implement policies, procedures and/or instructions necessary to meet this standard at the unit level.

1.11.4.2. Ensure workers are aware of and follow laser safety procedures in this standard, technical orders, manuals and unit Operating Instructions or other applicable documents.

1.11.4.3. Ensure workers who work regularly with or around lasers are trained on laser safety upon initial assignment to the unit and annually thereafter. As a minimum, workers shall be trained on safe work practices, specific hazards in their workplace, and procedures to follow in the event of a suspected exposure to laser radiation. Bioenvironmental Engineering can assist with this training.

1.11.4.4. Ensure the unit commander is immediately notified of any suspected exposures. Exposures will be reported to Bioenvironmental Engineering, Safety and Public Health Services. Appropriate medical treatment will be sought immediately.

1.11.4.5. Ensure any planned changes in laser operations are coordinated with, and if necessary, evaluated by, Bioenvironmental Engineering prior to becoming operational.

1.11.4.6. Designate unit personnel who require medical surveillance.

1.12. Unit Safety Officer (USO) or Designated Laser Safety Officer (LSO):

1.12.1. Will be appointed by the Unit Commander and assists the Unit Commander in developing policies, procedures, and instructions necessary; to meet this standard at the unit level.

1.12.2. Reports all suspected laser exposures to the Unit Commander.

1.12.3. Acts as a single point of contact for the unit on laser radiation safety matters and maintain active liaison with BE staff, PH, and SE personnel.

1.12.4. Coordinates laser radiation evaluation activities with command and supervisory personnel. Informs these individuals of the status of all such activities, particularly during investigations of suspected exposures.

1.12.5. Oversees all unit actions needed to minimize laser radiation hazards to personnel.

1.12.6. Conducts initial and annual laser safety training.

1.12.7. Ensures corrective actions are completed expeditiously.

1.13. Workplace Supervisors:

1.13.1. Assists the Unit Safety Officer and (or) LSO in maintaining safe and healthy work environment.

1.13.2. Ensures all employees receive required medical surveillance according to paragraph 2.5.

1.13.3. Promptly reports to the USO and (or) LSO any suspected laser exposure, any unsafe work condition, and (or) changes in laser use, which could change the hazard assessment.

1.13.4. Ensures any individual suspected of exposure to laser radiation receives prompt medical care per paragraph 2.6.

1.13.5. Ensures visitors receive proper instruction, personal protective equipment (PPE), when required, and permission to visit the area.

1.13.6. Documents that employees are adequately trained regarding the proper use of lasers and the hazards of lasers.

1.14. Individual:

1.14.1. Ensures proper handling and control of laser and laser beam by following procedures for safe work practices given in this standard, equipment TOs, manuals, and unit Operational Instructions (OIs).

1.14.2. Ensures required warning signs, safety devices, and PPE are functional and properly worn or placed before beginning work.

1.14.3. Assists co-workers in understanding and adhering to laser safety policies and procedure.

1.14.4. As soon as possible, reports to the supervisor and the Unit Safety Officer and (or) LSO any suspected laser exposure, any unsafe work condition, and (or) change in laser use that could change the hazard assessment.

1.14.5. Seeks immediate medical attention upon suspected exposure per paragraph 2.6.

Chapter 2

BASE PROGRAM

2.1. General Guidelines:

2.1.1. Each installation where lasers are used will organize and implement a laser radiation safety program under the general supervision of BE. While each base will have certain unique features, all should include the same fundamental aspects.

2.1.2. The fundamental aspects of a base laser safety program include evaluations of laser and ancillary hazards, safety training, medical surveillance, and accident and (or) incident investigation. These elements are described in detail in the paragraphs below and in the American National Standards Institute for the Safe Use of Lasers (ANSI Z136.1.)

2.2. Laser Radiation Hazard Evaluations:

2.2.1. Hazard Evaluation. A hazard evaluation must be accomplished and all required engineering and administrative controls must be in place prior to commencement of operations or maintenance for all readily accessible (non-interlocked, non-embedded, or both) laser systems of Class 3b, 4 and any Class 3a laser that exceeds 5 mW average power (i.e. any laser that requires the Danger sign). All military unique laser systems must have a hazard evaluation (i.e. GCP-1, GCP-2, MILES, and Saber 203). Ensure that the laser is properly labeled with the appropriate classification. Examples of systems **not** requiring a hazard evaluation include laser printers containing an embedded interlocked Class 4 laser. Use of the latest USAF approved software to derive the necessary safety parameters (i.e., Nominal Ocular Hazard Distance (NOHD) and Optical Density (OD)) is strongly recommended since it will incorporate the latest USAF laser safety policies. For unique lasers or laser applications, IERA Radiation Surveillance Division shall be contacted for assistance.

2.2.2. Laser Specifications. All laser specifications, as well as the laser hazard calculations for lasers that present a hazard under direct or specular viewing conditions must be evaluated and documented on the AF Form 2760, **Laser Hazard Evaluation**, or equivalent. (This includes Class 3a and 4 lasers and laser systems.) Additionally, lasers that will be used with optical viewing aids (i.e. binoculars) must be evaluated and documented on the AF Form 2760. Lasers that do not meet these requirements will be noted in the facility case file but the completion of a hazard evaluation and AF Form 2760 is not required. The unit laser safety officer will maintain the AF Form 2760 until disposition criteria are met. Consideration should be given to the following when accomplishing a laser hazard evaluation:

2.2.2.1. Laser emission characteristics. Specify whether it is pulsed or continuous wave, output power, or energy, wavelength(s), pulse width, pulse repetition frequency, diameter of the beam, beam waist, location of the beam waist relative to the output aperture, beam divergence, and beam symmetry.

2.2.2.2. The transmission of the laser beam through the atmosphere depends on the wavelength of the radiation, the altitude, length of the beam path, and the particulate and aerosol content of the air. In addition to attenuation, the atmosphere may, under some conditions, cause scintillation and local "hot spots" in the beam. These latter factors vary with the seasons, latitude, and climatic conditions, and their quantification is generally complex.

2.2.2.3. The attenuation of intervening materials (i.e., windows, windshields, canopies, and protective equipment) is highly dependent on the wavelength of the laser radiation and angle of incidence.

2.2.2.4. The use of optical viewing aids (i.e., binoculars, telescopes, etc.) can significantly increase the eye hazard from laser radiation, particularly when used to view a point source of radiation. The radiant energy entering the eye is increased by the magnifying power of the optical device used and decreased by the transmission loss of the device. These effects must be evaluated and proper protective measures specified if optical viewing is anticipated.

2.2.2.5. Many devices contain embedded lasers that are not normally accessible. These embedded lasers may present significantly greater hazards when maintenance is being performed on the unit then when the unit is in operation. Special attention should be given to work areas that may perform maintenance on systems with embedded lasers.

2.2.2.6. Evaluate beam path and termination points for potential specular or diffuse reflection hazards.

2.2.2.7. Any or all of the above factors may be significant and shall be considered carefully. Personnel safety and protection depend on the validity of the laser hazard evaluation. Other potential hazards, such as possible damage to protective materials, optical instruments, etc., must also be considered.

2.3. Ancillary Hazards:

2.3.1. General. In addition to direct hazards to the eyes and skin associated with exposure to the laser beam, it is also important to address other hazards associated with the use of lasers *(i.e.*, non-beam hazards). The non-beam hazards, in some cases, can be life threatening, (*e.g.*, electrocution). As a result, the special considerations discussed in this paragraph require use of control measures different from those discussed in Paragraph 4. Because of the diversity of these potential hazards, the Unit Safety Officer or LSO should employ SE, BE, or CEF to evaluate these hazards.

2.3.2. Description of Ancillary Hazards. Includes electrical, fire, explosion, laser generated air contaminants, ionizing and non-ionizing radiation, compressed gases, laser dyes, mechanical hazards associated with robotics, noise, waste disposal, confined space, and ergonomics. See ANSI Z136.1 for more details.

2.3.3. Targets, particularly with high-energy lasers, may disintegrate, causing a hazard from fragments or toxic residues. Furthermore, other hazards associated with lasers (i.e., electrical, cryogenic, toxic vapors, etc.) can exist and must be evaluated as described in paragraph 4.4.

2.4. Laser Safety Training Requirements:

2.4.1. Training. General laser safety training is required for users of readily accessible (non-embedded) laser systems as described in the ANSI Standard Z136.1. Users include operators, technicians, engineers, maintenance and service personnel, etc., working with or around lasers. The unit safety officer and (or) LSO will ensure that the users are knowledgeable of the potential laser and ancillary hazards and the control measures for laser equipment they may have occasion to use. Training should be conducted upon assignment to laser duties with refresher training annually. Additional training in cardiopulmonary resuscitation due to extreme electrical hazards may also be necessary as determined by SE and (or) BE. Incidental personnel and visitors should be given a briefing with enough informa-

tion to ensure no exposures occur. This should include descriptions of warning signs and lasers identification.

2.4.2. Training Level. Required training will be commensurate with potential laser hazards as outlined in the current ANSI Standard Z136.1.

2.4.3. BE and Laser Safety Personnel Training. BE, or other designated laser safety personnel, will be trained as outlined in the current ANSI Standard Z136.1.

2.5. Medical Surveillance:

2.5.1. General. Medical surveillance requirements are limited to personnel who routinely work in a laser environment. These personnel include, but are not limited to, laboratory personnel, aircrew, combat control teams, special operations forces and laser range personnel. Other personnel who do not work in a laser environment on a continuing basis will be considered incidental personnel. Supervisors will ensure that personnel who work with the most hazardous laser classes, as defined by the ANSI Standard Z136.1(exception MILES and HAVIS Shield as discussed in paragraph 4.2.3.), report to Public Health Services upon initial assignment. PH will review individual medical records and make referrals for required medical surveillance. Personnel working on less hazardous laser classes, as defined by the ANSI Standard Z136.1, do not require medical surveillance. Medical surveillance shall be accomplished for those working with the most hazardous classes of lasers. Personnel who visit or tour laser facilities are not subject to medical examination or surveillance unless a suspected exposure occurs. However, a cursory briefing should be given to these individuals to include descriptions of warning signs and laser identification.

2.5.2. Frequency of Medical Examinations. Pre- and post-employment medical examinations will be performed only before an individual's initial assignment to laser duties and as soon as practical subsequent to actual termination of duties involving lasers (i.e., Permanent Change of Station or Permanent Change of Assignment, retirement, or separation). Periodic examinations are not required. Following any suspected laser injury, the pertinent examinations, as determined by an appropriately qualified physician (i.e., ophthalmologist) will be performed.

2.5.3. Medical Examination Requirements. Minimum exam requirements are provided in the following paragraphs. Complete details on the listed exams are provided in ANSI Z136.1. Appendix E. The Air Force post-employment exam will follow the same requirements as the pre-employment exam.

2.5.3.1. Ocular History: Review past ocular history and family history for any conditions related to the eyes.

2.5.3.2. Visual Acuity: Best corrected, distant and near vision should be measured.

2.5.3.3. Macular Function: Test macular function with an Amsler grid using appropriate optical correction to determine if distortion or scotomas exist.

2.5.3.4. Color Vision: Use a pseudo-isochromatic plate test (red/green and/or blue/yellow) or similar color vision test to document color vision discrimination.

2.5.3.5. If any nonocular abnormalities are found, a more extensive examination will be conducted to determine underlying pathology.

2.5.4. Documentation. Results of all examinations will be recorded on SF 600, **Health Record - Chronological Record of Medical Care,** and filed in the individual's medical record, with the other occupational medicine examination documents. Supplemental documents, if any, will be attached. The MTF Commander will retain medical and surveillance records associated with laser safety per federal guideline and AF directive.

2.6. Investigation of Incidents and (or) Accidents:

2.6.1. Incident. Every incident involving a suspected laser radiation exposure to personnel covered by this standard will be investigated and documented. NOTE: Aircrew who receive a laser exposure from either friendly or hostile sources should immediately report to the Flight Surgeon's Office (FSO). The FSO will manage and coordinate the event with the MAJCOM, USAFSAM/AFC, 311th HSW/YA and AFRL as appropriate.

2.6.2. Alleged or Suspected Exposure. Whenever a suspected exposure to laser radiation occurs, the following steps will be taken:

2.6.2.1. Individuals exposed will seek medical care, without delay, at their host medical unit emergency treatment facility. THE LASER HOTLINE (1-800-473-3549) SHOULD BE CALLED ASAP BECAUSE IMMEDIATE INDICATED CARE IS CRITICAL. The individual's supervisor will be notified immediately and ensure action is taken to prevent injury to other personnel. Medical Care unit will perform an examination (see **attachment 2**) and implement appropriate procedures for reporting and investigating suspected Occupational Health Occurrences. The individual will be reexamined within 72 hours. In the case of an exposure to a military member or civil service employee in the Air National Guard, or the Reserves, the member will be sent to a contract ophthalmologist or military optometrist or ophthalmologist for examination. PH or any available flight surgeon will conduct a human factors evaluation of the incident for inclusion in the report. The individual will be reexamined within 72 hours. During a UTA weekend, the member may be initially evaluated by the base ophthalmologist, if available.

2.6.2.2. The immediate supervisor will immediately notify the unit commander and safety officer or LSO and the Bioenvironmental Engineer. The Bioenvironmental Engineer will notify wing safety, public health services, staff judge advocate, and MAJCOM medical staff immediately. Within 24 hours the Bioenvironmental Engineer will also notify the Tri-Service Laser Radiation Hotline at Brooks AFB, (see **attachment 3**). Tri-service Laser Radiation Hotline personnel will notify USAFSAM/AFC. PH will ensure the AFRESS, as described in 2.6.8., is initiated by the attending physician and forwarded to BE.

2.6.2.3. The unit safety officer and (or) LSO will keep the unit commander and other unit personnel informed of actions being taken or required as part of the medical investigation.

2.6.2.4. If the individual(s) suspected of exposure is being cared for in a non-AF medical treatment facility, the host USAF medical facility will ensure that a USAF physician calls the attending physician. This shall be accomplished within 24 hours in order to determine the clinical status of the individual and coordinate medical examination and treatment required by the USAF. PH will then ensure that the occupational physician initiates the AFRESS, as described in 2.6.8. and forwards it to the BE. The occupational physician will initiate the investigation in coordination with BE. When the individual is released or transferred to USAF care, the attending USAF physician will obtain and review the record of examination and care given by the non-AF facility and ensure

all USAF medical examination requirements have been met. A copy of the incident and (or) accident report must be filed in the medical record of each exposed person. In the case of an exposure of a military member or civil service employee in the Air National Guard (ANG), the PH of the ANG base will contact the attending physician within 24 hours to determine whether, in the case of a military member, referral to a military MTF is required. In the case of a civil service employee, the PH will ascertain from the treating physician whether further consultation with a specialized practitioner familiar with laser eye injuries is necessary. An occupational medicine consultation with USAFSAM may be required.

2.6.2.5. If it is known or suspected that a defect of any kind in a laser may have caused the injury, the laser shall be immediately taken out of service until the deficiency has been corrected.

2.6.3. Investigation. Upon notification of a suspected exposure, BE will promptly investigate the incident or accident and determine the following:

2.6.3.1. Name, rank, and social security account number (SSAN) of individual alleged or suspected to have been overexposed. This investigation is separate from, but may become a part of, any mishap investigation conducted under AFI 91-301, Air Force Occupational and Environmental Safety, Fire Protection and Health Program.

2.6.3.2. Laser nomenclature, characteristics and operating parameters at the time of the incident (wavelength, peak and average power, pulse width and frequency, beam diameter and divergence, etc.) including those parameters that may be classified.

2.6.3.3. Date, place, unit, time, and duration of the exposure, and the individual's position relative to the laser.

2.6.3.4. Description of what happened. If possible, obtain signed brief narrative statements from all individuals who have first-hand knowledge of the incident per AFI 91-301.

2.6.3.5. Personal Protective Equipment (PPE) and (or) clothing in use at the time of the accident, and eyewear transmission characteristics at the wavelength of the laser.

2.6.3.6. Facility configuration at time of the event.

2.6.3.7. Name, rank, address, and telephone number of the attending physician. If the attending physician is other than a USAF physician, give name, rank, title, address, and telephone number of the consulting USAF physician.

2.6.4. Reconstruction. It is essential that the event be reconstructed by BE if possible and measurements and (or) calculations made to ascertain as nearly as possible the exposure level to the individuals. If the equipment and expertise do not exist locally to fully investigate and reconstruct the incident, support should be requested from another source. Telephone consultation with the MAJCOM Bioenvironmental Engineer (BEE), and IERA Radiation Surveillance Division (see **attachment 3**) is strongly recommended. USAFE and PACAF installations should also contact 86 MDSS/SGSB for USAFE and Det 3, IERA for PACAF, respectively (see **attachment 3**.)

2.6.5. Interim Report. Upon completion of the investigation, the BEE will provide a detailed report of their findings to PH, SE, Installation Staff Judge Advocate, and the Command BE within 30 workdays. The report will include at a minimum the following:

2.6.5.1. Date, time, and place the incident occurred.

2.6.5.2. Name, rank, and SSAN of each individual exposed.

2.6.5.3. Identification of the investigating officer.

2.6.5.4. Narrative description of the incident, including what was believed to be the cause, and a timetable of medical actions taken.

2.6.5.5. Complete identification of the laser, including the operating parameters and configuration at the time of the incident. Classified data will be omitted, but a specific reference to the document containing the data will be given.

2.6.5.6. Complete identification, including calibration date, of the measurement equipment used.

2.6.5.7. Exposure estimates determined by reconstruction of the incident.

2.6.5.8. Recommendations to prevent recurrence of the incident.

2.6.6. Final Report. Within 45 workdays following submission of the investigation report, BE will prepare and coordinate with appropriate installation organizations a final detailed report consisting of a summary of the estimated exposure, time table of medical evaluations, discussion of further medical follow-up recommendations, copies of the reconstruction report; and copies of all narrative statements and medical evaluations. BE will then forward the report information through their chain of command to AFMOA/SGOR with a courtesy copy to IERA Radiation Surveillance Division (see **attachment 3**) for entry into the laser incident repository. BE will coordinate with PH to ensure a copy is placed in each individual's medical records and placed in Tab F of the appropriate case file. This report is in addition to the 30-day report described in paragraph 2.6.5.

2.6.7. Individual Medical Records. PH personnel will ensure a copy of all forms and reports concerning the incident and relating to an exposed individual are included in each individual's medical record.

2.6.8. Reporting Documentation. Documented exposures will be considered an occupational illness and reported to the Air Force Reportable Event Surveillance System (AFRESS). The medical authority on clinical evaluations and long-term medical follow-up of incidents is USAFSAM/AFCO.

Chapter 3

CONSIDERATIONS FOR LASER EVALUATION

3.1. Terminology Used to Identify Hazard Areas:

3.1.1. Maximum Permissible Exposure (MPE). The MPE is the value of energy deposition below which no adverse biological effect is expected. MPEs are typically calculated in terms of ocular (eyes) and skin which are the two critical organs of interest for laser damage. Ocular and skin MPEs are largely dependent on wavelength of the laser light and the exposure duration. Hence, both of these variables need to be taken into account when calculating the MPE for a given laser operation. Personnel will not be exposed to laser radiation in excess of the MPE, and unnecessary exposures to laser radiation below the MPE will be avoided. This AFOSH Standard has accepted the MPE and classification procedure found in the current version of ANSI Z136.1.

3.1.2. Nominal Ocular Hazard Distance (NOHD). NOHD is the distance from the output aperture along beam propagation in which irradiance or radiant exposure is not expected to exceed the appropriate MPE for unobstructed viewing by the human eye. This distance is the basis for determining the nominal hazard zone. The NOHD for many military systems is corrected for atmospheric attenuation in the Military Handbook 828A.

3.1.3. Nominal Hazard Zone (NHZ). NHZ describes the space in which laser radiation during operations exceed the applicable MPE including the possibility of optically aided viewing. Personnel within this zone shall be provided PPE (i.e. laser eye protection) and training for its use. For indoor use, this will typically be the entire room in which operations are performed. For outdoor use, a laser footprint is determined.

3.1.4. Laser Footprint. The laser footprint is a modified NHZ that considers possible firing direction, elevation, accuracy, and backstops. The laser footprint is used in evaluation of laser range operations.

3.1.5. In-Band . In-band refers to visible wavelengths in the electromagnetic spectrum (i.e. red, green, blue.)

3.1.6. Out-of-Band. Out-of-band refers to invisible wavelengths in the electromagnetic spectrum (ultraviolet, infrared.)

3.2. Intrabeam Viewing. Sources such as laser arrays, diodes, and diffuse reflecting surfaces are considered to give rise to intrabeam viewing conditions if their angular subtenses are equal to or less than minimum angular subtense, a_{min}. Intrabeam viewing includes lasers with collimated beams that produce a small retinal image of 20-30 microns. In addition, a_{min} varies according to the exposure duration. For further details, refer to paragraph 8, figure B3 and examples in ANSI Z136.1. The current USAF approved laser hazard analysis software (LHAZ) automatically determines if viewing conditions require extended or point source consideration.

3.3. Atmospheric Attenuation. Beam irradiance *E* or radiant exposure *H,* at a range *r,* for a nondiverging beam which is attenuated by the atmosphere, can be expressed as:

$E = E_0 e^{-\mu r}$

and

$H = H_0 e^{-\mu r}$.

The atmospheric attenuation coefficient m varies from 10^{-4} cm^{-1} in thick fog to 10^{-7} cm^{-1} in air of good visibility. The effect of aerosols (i.e., dust particles, water vapor, etc.) in even the cleanest atmospheres usually raises m at a wavelength of 1 mm to ~$5x10^{-7}$ cm^{-1}. The use of atmospheric attenuation coefficients can reduce large calculated hazard distances (>2 km). For an example, in a vacuum (m =0), a given system has a NOHD of about 12 km. The hazard distance will reduce to about 8 km when atmospheric attenuation is used in the NOHD calculations. This standard authorizes use of atmospheric attenuation coefficients in laser safety to support critical mission requirements. Use of atmospheric attenuation coefficient for laser safety should be coordinated with IERA Radiation Surveillance Division (see **attachment 3**).

3.4. Laser Classification:

3.4.1. Laser Classes. Lasers are usually classified by the manufacturer per Federal Drug Administration Standard (21 CFR 1040.10), MIL-STD-1425A, *Military Standard for Safety Design Requirements for Military lasers and Support Equipment*, and ANSI Z136.1. Refer to the most recent ANSI Z136.1 for laser classification information

3.4.2. Classification Parameters. If classification has not been determined, IERA/SDRH can assist in classifying the system per ANSI Standard Z136.1. The following parameters are required for classification.

3.4.2.1. Name, model number and manufacturer of the laser.

3.4.2.2. Divergence, spot size, beam symmetry, wavelengths or wavelength range.

3.4.2.3. For CW or repetitively pulsed lasers: average power output and limiting exposure duration T_{max} inherent in the design or intended use of the laser or laser system; and

3.4.2.4. For pulsed lasers: total energy per pulse (or peak power), pulse duration, pulse repetition frequency, and emergent beam radiant exposure.

3.4.3. Classification of Extended-Source Lasers or Laser Systems. Extended-source lasers (such as laser arrays, injection laser diodes, and lasers having a permanent diffuser within the output optics) require, in addition to the laser emission characteristics listed in 3.4.2, knowledge of the viewing angle subtended by the source.

3.5. Medical Laser Evaluations. Further guidance in the evaluation of medical lasers can be found in ANSI Standard Z136.3, *American National Standard for Safe Use of Lasers in Health Care Facilities.*

3.6. Fiber Optical Communication. Further guidance can be found in ANSI Standard Z136.2, *Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources.*

Chapter 4

CONTROL MEASURES

4.1. General Considerations. Control measures shall be devised to reduce the possibility of exposure of the eye and skin to hazardous levels of laser radiation and to other hazards associated with the operation of laser devices during operation and maintenance. See ANSI Z136.1 for a summary of controls measures applicable to each class of laser.

4.2. Special Considerations.

4.2.1. Laser Range Operations:

4.2.1.1. Guidance on the use of laser designators, illuminators and pointers on Air Force ranges is contained in several publications. The guidance addresses the use of both airborne and ground systems. The publications which address the use of laser systems on Air Force ranges are ANSI Standard Z136.6, *American National Standard for Safe Use of Lasers Outdoors*, Military Handbook (MIL-HDBK) 828A, *Laser Safety on Ranges and in Other Outdoor Areas*, Air Force Instruction (AFI) 13-212, *Test and Training Range Policy*, and DoD Directive 316-98, *Laser Range Safety*. Information on obtaining these documents is provided at **attachment 1**.

4.2.1.2. Ranges using lasers will be certified in accordance with AFI 13-212, *Test and Training Range Policy*, which mandates laser range surveys as a requirement for laser range certification. This AFI designates IERA as the service center for coordinating and accomplishing range surveys in support of certification requirements. IERA will conduct a laser range survey and will provide a formal written report to the range commander, BE and MAJCOM POCs. Once the range's laser safety program has met the recommendations in this report, it is certified safe for those laser operations evaluated in the report.

4.2.2. Outdoor Laser Light Shows. Outdoor laser light shows may adversely impact military aircraft operations by temporarily flash-blinding or distracting aircrew during critical phases of flight. Guidance relative to controlling hazards associated with these operations can be found in United States Department of Transportation, Federal Aviation Administration Order 7400.2D, *Procedures for Handling Airspace Matters* and. ANSI Standard Z136.6, *American National Standard for Safe Use of Lasers Outdoors* (See **attachment 1**).

4.2.3. Combat Simulation Systems:

4.2.3.1. Multiple Integrated Laser Engagement System (MILES): The MILES system uses a medium power infrared laser that can be mounted on a variety of weapons. Information concerning laser classification and NOHDs for the MILES laser can be found in MIL HDBK 828A.

4.2.3.2. HAVIS Shield M16 Aiming Laser Light Assembly: This assembly uses a Gallium-Arsenide semiconductor laser emitting in the near infrared region at 850 nanometers. It is designed to be used in conjunction with night vision goggles on DoD controlled land.

4.2.3.3. Users of these systems shall be briefed annually on hazards and correct use by the USO or the LSO.

4.2.3.4. According to FDA Exemption No. 76 EL-01-DOD, units possessing these systems or any military exempt laser system will maintain accountability and not release them outside the DoD unless properly demilitarized (i.e., made inoperable).

4.2.3.5. Formal laser range evaluations for MILES and HAVIS Shield are not required.

4.2.3.6. Personnel using these devices are exempt from medical surveillance requirements specified in paragraph 2.5.

4.2.3.7. Additional Combat Simulation Systems will be documented in Military Handbook 828A as DoD establishes policies regarding these systems.

4.3. Protective Equipment.

4.3.1. General. Enclosure of the laser equipment or beam path is the preferred method of control, since the enclosure will isolate or minimize the hazard. Though enclosure is the optimal method of control, this method may not be warranted for some systems and facilities (i.e., laser ranges and laser pointers).

4.3.2. Protective Eyewear:

4.3.2.1. Air Force ground personnel may acquire laser eye protection (LEP) through the supply system or commercially. Contact IERA Radiation Surveillance Division to obtain the current list of LEP available commercially and through the military supply system.

4.3.2.2. LEP (visors, spectacles, etc.) for aircrew may not be used without prior “Safe-to-Fly” approval from the 311 HSW/YA or the MAJCOM. Aircrew LEP users may contact 311 HSW/YA for additional guidance on acquisition of LEP.

4.3.3. Skin Protection. Skin protection can best be achieved through engineering controls, which terminate, or enclose, the laser radiation. The potential exists for damaging skin exposure, particularly for ultraviolet lasers (180 - 400 nm). If engineering controls are not sufficient in protecting the skin, then skin covers and (or) "sun screen" creams for UV exposure are recommended. Most gloves will provide some protection against laser radiation. Tightly woven fabrics and opaque gloves provide the best protection. A laboratory jacket or coat can provide protection for the arms. For Class 4 lasers, consideration shall be given to flame-retardant materials.

4.3.4. Other PPE. Respirators, additional local exhaust ventilation, fire extinguishers, and hearing protection may be required whenever engineering controls cannot provide protection from a harmful ancillary environment.

4.4. Laser Hazard Warning Signs and Labels:

4.4.1. Labeling per Federal Law, 21 CFR 1040.10 and 1040.11, and MIL-STD-1425A, *Safety Design Requirements for Military Lasers and Associated Support Equipment*, may be used to satisfy the labeling requirement.

4.4.2. Sign dimensions, letter size, and color, etc., shall be per the requirements of the ANSI Z535-series, *American National Standard Specification for Accident Prevention Signs* (latest revision). ANSI Z136.1 contains sample signs for different classes of lasers or laser systems. These signs are available commercially or through the US Navy Publications Office in Philadelphia, PA.

4.5. Service, Repair and Modification of Laser Systems (All Classes). Whenever the service, repair, or modification of a laser or laser system may make the output power or operating characteristics more hazardous, the LSO shall determine if any changes are required in control measures. An alternative is to reclassify the laser or the system.

Chapter 5

APPROVAL OF NEW LASER SYSTEMS

5.1. General Considerations. New operational laser systems are continuing to enter the inventory without proper control, training and laser range safety evaluation. In addition to the requirements set forth in this standard, the following procedure shall be followed for approval of new laser systems in the Air Force and review and approval of FDA exempt status requests.

5.1.1. The system safety evaluation provided by IERA/SDRH, Concept of Operations, any Technical Orders or Operating Instructions, FDA exemption, if applicable, and any pertinent JAG review will be forwarded to AFMOA/SGOR for review and approval.

5.1.2. AFMOA/SGOR shall chair and coordinate this package with a Laser System Safety Review Board that will consist of AFMOA/SGOA, AFMOA/SGOE, AFMOA/SGOR, IERA/SDRH, AFRL/HEDO, and USAFSAM/AFC for review and final approval by AFMOA/SGO. HQ AFSC will participate as a member for review of any laser system that is part of a weapon. The 311 HSW/YA will participate when the new system requires an upgrade to existing LEP capabilities, or otherwise requires integration with existing Life Support Equipment, as appropriate. Any approved laser system will be added to the HAZMAT pharmacy inventory with an indicator to the base Bioenvironmental Engineer to be notified upon entry of this commodity onto the base. The results of these hazard analyses will be reported to the Deputy Under Secretary of Defense for Environmental Safety Working Group (LSSWG) for inclusion in the military handbooks.

5.1.3. Request for FDA Exemption per DoDI 6055.11 must be reviewed by IERA/SDRH and a recommendation forwarded to AFMOA/SGOR for final approval via the Laser System Safety Review Board.

5.1.4. Lasers that are contained (i.e. laser printers) and research lasers are exempt from this approval process requirement.

5.2. Forms Prescribed.

5.2.1. SF 600, Health Record - Chronological Record of Medical Care.

5.2.2. Air Force Form 847, Recommendation for Change of Publication.

5.2.3. Air Force Form 2760, Laser Hazard Evaluation.

PAUL K. CARLTON, JR., Lt General, USAF, MC
Surgeon General

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

Air Force Instruction (AFI) 13-212, *Test and Training Range Policy*.

AFI 48-101, *Aerospace Medicine Program.*

AFI 91-202, *The US Air Force Mishap Prevention Program*, Chapter 9, *System Safety*.

AFI 91-204, *Investigating and Reporting US Air Force Mishaps*.

AFI 91-301, *Air Force Occupational and Environmental Safety, Fire Protection, and Health (AFOSH) Program* (formerly designated as AFR 127-12).

Air Force Occupational Safety and Health (AFOSH) Standard 48-17, *Standardized Occupational Health Program* (formerly designated as AFOSH Standard 161-17).

American National Standard Institute (ANSI) Z136-1, *American National Standard for Safe Use of Lasers*.

ANSI Z136.2, *Safe Use of Optical Fiber Communications Systems Utilizing Laser Diode and LED Sources*.

ANSI Z136.3, *American National Standard for Safe Use of Lasers in Health Care Facilities*.

ANSI Z535-series, *American National Standard for Accident Prevention Signs*.

Department of Defense (DoD) 6055.11, *Control of Radiofrequency Radiation and Exempt Lasers*.

DoD Directive 316-98, *Laser Range Safety*.

Federal Aviation Administration (FAA) Order 7400.2D, *Procedures for Handling Aerospace Matters*.

Food and Drug Administration (FDA) Exemption No. 76 EL-01-DOD,

Military Handbook (Mil-HDBK) 828A, *Laser Safety on Ranges and in Other Outdoor Areas*.

Title 21, Code of Federal Regulations (CFR), Part 1040.10.

NOTES:
1. Title 21, Code of Federal Regulations Part 1040.10 document can be obtained by writing to the Government Printing Office (GPO), Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, accessing them on the web at http://www.access.gpo.gov/su_docs/, calling customer service at 1-888-293-6498, or by e-mail at gpoaccess@gpo.gov. In addition, the Installation Staff Judge Advocate may have a copy of this document.
2. American National Standards Institute (ANSI) Z136- and Z535-series publications can be obtained by writing to American National Standards Institute, 11 West 42nd Street, New York NY 10036, calling customer service at (212) 302-1286, or on the web at http://web.ansi.org/default_js.htm.
3. DoD, FAA, and FDA documents can be obtained by writing to the 311 HSW IERA/SDRH (Radiation Surveillance Division), 2402 E Street, Brooks AFB TX 78235, or by calling (210) 536-5585.
4. Some Air Force publications must be obtained through your PDO. Others (AFIs, AFOSH, etc.) can be obtained on the web at http://afpubs.hq.af.mil.

5. Military Handbook 828A, *Laser Safety on Ranges and in Other Outdoor Areas* and Military Handbook 882, *System Safety Program Requirements* can be obtained by writing Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

Abbreviations

ACGIH—American Conference of Governmental Industrial Hygienists

AF—Air Force

AFSC—Air Force Safety Center

AFI—Air Force Instruction

AFIA—Air Force Inspection Agency

AFLSA—Air Force Logistics and Support Agency

AFMC—Air Force Material Command

AFMOA—Air Force Medical Operations Agency

AFOSH—Air Force Occupational Safety and Health

AFRC—Air Force Reserve Command

AFRESS—Air Force Reportable Event Surveillance System

AFRL—Air Force Research Laboratory

ANG—Air National Guard

ANSI—American National Standards Institute

BE—Bioenvironmental Engineering

BEE—Bioenvironmental Engineer

CFR—Code of Federal Regulations

cm—Centimeter

CW—Continuous Wave

DoD—Department of Defense

DoDI—Department of Defense Instruction

DRU—Direct Reporting Unit

IERA—Institute for Environment, Safety, Occupational Health, and Risk Analysis

FDA—Food and Drug Administration

FOA—Field Operating Agency

HQ—Headquarters

HSW—Human Systems Wing

km—Kilometer

LED—Light Emitting Diode

LEP—Laser Eye Protection

LHAZ—Laser Hazard Analysis Software

LSO—Laser Safety Officer

LSSWG—Laser Systems Safety Working Group

MAJCOM—Major Command

MILES—Multiple Integrated Laser Engagement System

Mil-Hdbk—Military Handbook

Mil Std—Military Standard

MPE—Maximum Permissible Exposure

MTF—Medical Treatment Facility

NHZ—Nominal Hazard Zone

nm—Nanometers

NOHD—Nominal Ocular Hazard Distance

OD—Optical Density

OI—Operating Instruction

PACAF—Pacific Air Forces

PDO—Publishing Distribution Office

PH—Public Health

PPE—Personal Protective Equipment

psi—pounds per square inch

rpm—revolutions per minute

RDT&E—Research, Development, Test and Evaluation

SAF—Secretary of the Air Force

SE—Safety

SF—Standard Form

SSAN—Social Security Account Number

TO—Technical Order

US—United States

USAF—United States Air Force

USAFE—United States Air Forces in Europe

USAFSAM—United States Air Force School of Aerospace Medicine

WWW—World-Wide Web

Terms

May—Indicates an acceptable or satisfactory method of accomplishment.

Shall—Indicates a mandatory requirement.

Should—Indicates a preferred method of accomplishment

Will—Is also used to indicate a mandatory requirement and in addition is used to express a declaration of intent, probability, or determination.

Attachment 2

PROCEDURES FOR MEDICAL EVALUATION OF PERSONNEL FOLLOWING SUSPECTED EXPOSURE

A2.1. Individual should immediately report to the Medical Treatment Facility whenever eye exposure to laser light is suspected.

A2.2. An examination should be done and will include at minimum the following:

A2.2.1. Medical history.

A2.2.2. External examination including skin.

A2.2.3. Best corrected visual acuity (near and far).

A2.2.4. Amsler grid.

A2.2.5. Stereopsis.

A2.2.6. Color vision.

A2.2.7. Non-dilated fundoscopy (dilated examination is recommended.).

A2.3. If the results of the examination are normal and the individual does not have any persistent visual complaints, the individual can be returned to duty. Normal is defined as normal for the individual.

A2.4. If the results of the initial examination performed are abnormal or questionable, additional examination will be conducted to include:

A2.4.1. Pupil examination.

A2.4.2. Slit lamp biomicroscopy.

A2.4.3. Dilated fundoscopy.

A2.4.4. Retinal photography.

A2.5. If the results of the additional examination do not provide any questionable abnormalities, contact The Tri-Service hotline at (800) 473-3549.

A2.6. If the results of the additional examination are abnormal or questionable, individual will be referred for a full and thorough ocular examination which may include retinal photographs, visual fields, color vision testing, fluorescent angiography, and other tests as appropriate. Contact the USAF School of Aerospace Medicine for further action.

Attachment 3

RECOMMENDED GUIDELINES FOR EVALUATING LASER OPERATIONS

This attachment provides recommended general guidelines and recommended procedures for evaluating lasers in a work area. Due to the diverse nature of potential scenarios and laser systems it is impossible to address every potential situation that may arise. For this reason, these guidelines should be considered recommended practice and should be modified or expanded, as the situation requires.

A3.1. Evaluation of Laser Operations

A3.1.1. Identification and Classification. The first step to evaluating lasers in a work area is to identify all laser systems that are currently used. This can be accomplished by consulting the facility case file, talking with the work area supervisor, talking with the unit LSO (if one exists), or during a walk-through of the facility.

A3.1.2. The classification of each system found in the work area should be determined. The classification of a laser system can be obtained from a variety of sources. These include but are not limited to manufacturer's literature, laser warning labels on the device, Mil-Handbook 828A (for military systems), AFRL and IERA consult letters, or by contacting the manufacturer directly. It is not necessary at this stage to collect all of the information to complete an AF Form 2760; only the classification of each laser needs to be determined at this point.

A3.1.3. Special care should be taken for systems that have not been previously classified. The classification of laser systems can be a complex and involved process for some types of systems. There are many types of lasers that may have unique properties and/or applications. Some such systems include laser communication systems, laser arrays, non-uniform beam lasers, etc. These lasers require special consideration when classified. Additionally some systems may not have all of their parameters characterized sufficiently to classify. Contact IERA/SDRH for further assistance.

A3.2. Hazard Analysis, Evaluation and Documentation. The next step in the process is to evaluate the hazards associated with each system.

A3.2.1. Evaluation of Class 1, 2 and 2a Systems. Class 1, 2, and 2a systems present little or no health hazard if used properly. The evaluation of these systems can consist of ensuring that the controls required in ANSI Standard Z136.1 are in place. These controls include but are not limited to a protective housing on the laser and the proper warning labels on the laser. Documentation of the hazard can be accomplished by noting the existence of these systems in the facility case file. An inventory of the systems is not necessary, only mentioning that class 1, 2, or 2a laser systems are used in the work area should suffice.

A3.2.2. Evaluation of Class 3a Systems. Class 3a laser systems do not present a serious health hazard if used properly. The evaluation of these systems is similar to that of class 1, 2, and 2a systems. The primary difference is that training is recommended for users of class 3a lasers although not required.

A3.2.3. Evaluation of Class 3b and 4 Systems. Class 3b and 4 lasers can present small to significant health hazards even if used properly. More care must be taken in the analysis, evaluation and documentation of hazards associated with class 3b and 4 lasers because of the ability of class 3b and 4 lasers to cause eye damage after even brief exposures and in the case of class 4 lasers to present skin exposure and diffuse reflection hazards. This includes the evaluation of engineering control systems

(i.e. interlocks, key controls), the determination of the proper laser eye protection if necessary, the completion of the appropriate forms, etc.

A3.2.4. Evaluation: Each class 3b and 4 laser in the area should be evaluated. This should, as a minimum, include the following items:

A3.2.4.1. Laser classification

A3.2.4.2. Determination of NOHD and NHZ

A3.2.4.3. Engineering Controls Required and Recommended

A3.2.4.4. Determination of Appropriate Laser Eye Protection (if necessary)

A3.2.4.5. Evaluation of User Training

A3.2.4.6. Review of SOPS (if necessary)

A3.2.4.7. Evaluation of non-beam hazards (fire, electrocution, hazardous chemicals, etc.)

A3.2.5. Documentation. The evaluation of class 3b and 4 systems should be documented in a variety of places. This should include but is not limited to the AF Form 2760, AF Form 2754, and possibly AF Form 2755. The AF Form 2754 should list class 3b and 4 lasers as a potential exposure due to the fact that occupational exams are required for users of these systems.

A3.2.6. AF Form 2760. The AF Form should be used as the primary method of documenting the hazards associated with class 3b and 4 lasers. Information for completing this form can be obtained from a variety of sources. These include but are not limited to manufacturer's literature, manufacturer's representative, LHAZ 3.0 (or the most current AF laser hazard evaluation software), or IERA/SDRH. As with the classification of laser systems some of the information required on the AF Form 2760 could be difficult to determine for some laser systems. The individual completing the form should be properly trained in laser safety such that they have a complete understanding as to the meaning of the items and the methods used to determine them. For assistance in completing AF Form 2760 contact IERA/SDRH.

A3.3. Evaluation of Engineering and Administrative Controls

A3.3.1. Once all laser systems in a work area have been identified and evaluated the next step should be to evaluate any engineering and/or administrative controls that are already present. Additionally any additional controls necessary to control potential health hazards should be identified at this time.

A3.3.2. Controls that are already in place should be checked to ensure that they are operating properly. This includes checking interlocks to ensure that they are still functional.

A3.3.3. Laser Eye Protection should be examined to ensure that it provides sufficient optical density for the laser used. It should also be in a usable condition (i.e. not excessively worn, no broken straps, etc.)

A3.3.4. Controls for potential non-beam hazardous should also be evaluated. This can include such items as ventilation systems, shielding for ionizing radiation, radiofrequency exposure controls, etc. The type of controls required will be dependent on the laser and the operation.

A3.4. Other Considerations. There are several other items that may be considered as part of a laser evaluation.

A3.4.1. Many laser systems use hazardous chemicals in there operation. Some of these chemicals are highly toxic such as hydrogen fluoride. These chemicals may have to be disposed of as hazardous waste or at a minimum have be characterized. Dye lasers in particular use many chemicals that may be classified as hazardous waste.

A3.4.2. Medical lasers and fiber optic systems may require special considerations when they are evaluated. ANSI Standard Z136.2 and ANSI Standard Z136.3 should be used as guidelines for these considerations.

A3.4.3. Recommendations: All recommendations should be documented in the facility case file. If a significant hazard is present in a work area the assignment of a Risk Assessment Code (RAC) should be considered.

Attachment 4

POINTS-OF-CONTACT

A4.1. Institute for Environment, Safety, Occupational Health and Risk Assessment/Radiation Surveillance Division (formerly Det 1, HSC/OEBZ): IERA/SDRH, 2402 E Drive, Brooks AFB TX 78235, DSN 240-3486 or (210) 536-3486.

A4.2. Air Force Research Laboratory/Optical Radiation Branch (formerly Det 1, HSC/OEO): AFRL/HEDO, 8111 18th Street, Brooks AFB TX 78235, DSN 240-4784 or (210) 536-4784. http://www.brooks.af.mil/AFRL/HED/HEDO/lasers.htm

A4.3. Air Force Medical Operations Agency Radiation Protection Division (AFMOA/SGOR): 110 Luke Avenue Room 405, Bolling AFB DC 20332, DSN 297-4313 or (202) 767-4313.

A4.4. 86 MDSS/SGSB, USAFE Environmental Health Consultant Service: DSN 496-6782.

A4.5. Det 3, IERA (PACAF): Douglas Blvd, Bldg. 850, APO AP 96368-5213, Technical Expertise: DSN 315-634-1769.

A4.6. United States Air Force School of Aerospace Medicine Opthamology Branch (USAFSAM/AFC): 2507 Kennedy Circle, Brooks AFB TX 78235-5117, DSN 240-3241 or (210) 536-3241.

A4.7. Human Systems Program Office, 311 HSW/YA, 7909 Lindbergh Drive, Brooks AFB, TX 78235-5352

A4.8. Tri-service Laser Hotline 1-800-473-3549